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Abstract

With regard to reducing fuel consumption and CO_2 emissions of road transport consumers' adoption of fuel-efficient vehicles is crucial. However, facing the ongoing trend of increasing car size and power, fuel consumption is apparently of lesser importance to most buyers. For the design of effective measures to change behavior and promote fuel-efficient cars, psychological factors should be considered. Drawing from psychological research on environmental behavior, we propose a model which integrates psychological variables to explain the purchase of fuel-efficient vehicles by private consumers. This model is tested with survey data from 302 Swiss respondents whose households have bought a new car since 2002. SEM analyses confirm personal norm, valence of less power and smaller size, and perceived behavioral control as direct predictors of the purchase of a fuel-efficient vehicle. Problem awareness, symbolic motives, and response efficacy influence the respective behavior indirectly via affecting the direct predictors. The design, implementation and evaluation of measures aimed at changing car choice behavior with respect to fuel consumption should account for these factors.

Keywords: Norm-activation model; Theory of planned behavior; Symbolic motives; Car purchase; Fuel consumption; CO_2 emissions

1 Introduction

Facing the global challenges of climate change and energy supply security, increasing fuel efficiency of new vehicles belongs to the most significant options to reduce fossil energy consumption of road transport (IPCC, 2007a). Besides technical solutions, a large potential for improvement in fuel efficiency persists in enhancing consumers' adoption of fuel-efficient cars (DeCicco, 2006). In the last 10 years, average CO_2 emissions of European new car registrations decreased by approximately 1% per year. The decrease would have been greater if consumers had not purchased bigger and faster cars (Zachariadis, 2006). In Switzerland, where we conducted this study, passenger cars are, on average, even heavier and have more engine capacity than those in the rest of Western Europe. This might be due to the high Swiss gross domestic product per capita. Nevertheless, the general trends are the same.

Large differences in efficiency still exist between different versions of almost any given vehicle model (de Haan, Mueller, & Scholz, 2009). For example, for the 15 most-sold passenger car models in Switzerland in 2007, a change from the least efficient version to the most efficient version would mean on average a reduction of 40.3% of CO_2 emissions (94g CO_2/km) which are directly linked to fuel consumption. Hence, effective pro-environmental purchase behavior could already be if people change to less fuel consuming vehicles within their preferred car size class, i.e., to vehicles which – in relationship to functional vehicle parameters, such as vehicle size or luggage capacity - are fuel-efficient (cf. Peters, Mueller, de Haan, & Scholz, 2008).

For the choice and design of interventions, it is crucial to know which factors influence vehicle choice of consumers with regard to fuel consumption. Research has shown that various psychological variables such as specific beliefs, attitudes, norms, and motives influence most types of environmental behaviors (Bamberg & Möser, 2007). Regarding the topic of car purchase, published studies which integrate a pool of variables derived from psychological theory are rare (though presumably, a lot of proprietary research on the role of psychological factors within vehicle choice exists). Published models to forecast car buying behavior have been developed mainly by economists and market researchers (Choo & Mokhtarian, 2004). However, these models have differentiated consumers primarily by their socio-demographic characteristics. The incorporation of psychological factors is a rather new approach. Choo and Mokhtarian (2004) showed that the inclusion of psychological constructs such as attitudes, personality, and lifestyle contributes substantially to the predictive power of vehicle choice models. However, additional work, based on comprehensive psychological theories, is necessary to identify which variables are decisive for vehicle purchase behavior.

2 Factors influencing environmental behavior with special regard to car purchase

The aim of the current paper is to identify, based on proven theories, the relevant subset of psychological variables influencing the purchase of new cars with regard to fuel consumption. In the field of vehicles with alternative fuels and technology, respectively, technology adoption and diffusion theories are applied to explain how and why such alternative vehicles are adopted by consumers and become widespread or not (Struben & Sterman, 2008). The dominant theory,

Diffusion of Innovation Theory by Rogers (2003), explains the variance in adoption rates by both attributes of the innovation and of the consumers. Consumers´ specific perception of the innovation on five dimensions (relative advantage, value compatibility, complexity, trialability and observability) influences the formation of specific attitudes towards the innovation. In the field of vehicles with fuel-efficient technology, it is similarly important to characterize consumers with regard to attributes relevant for the adoption. The relevance of attitudes and outcomes is also explained by the theory of planned behavior (TPB, Ajzen, 1991; Fishbein & Ajzen, 2010) which is – besides the norm-activation model (NAM, Schwartz, 1977; Schwartz & Howard, 1981) – the theory most applied by environmental psychologists to study behaviors of environmental relevance. The NAM shifts the view to explicit normative and moral motivations of behavior.

In order to integrate the various determinants proven to influence environmental behavior, Bamberg and Möser (2007) propose a structural model integrating TPB and NAM confirmed by a meta-analysis based on 46 studies of a variety of environmental behaviors. Their model accordingly represents a well-validated model of pro-environmental behavior, and we thus adopted it with a few adaptations for the case of car purchase behavior.

According to the TPB, behavior is immediately influenced by a person's intention to perform the behavior. Intention, in turn, is determined by (1) a person's attitude towards the behavior, defined as an overall evaluation of its possible consequences, (2) subjective norms, referring to the perceived expectations of other important persons (we will speak of social norms in the following), and (3) the perceived behavioral control (PBC), defined as a person's perceived power to

perform the behavior due to non-motivational factors as availability of opportunities and resources. Besides the indirect influence of PBC on behavior via intention, a direct one can also be assumed to the extent that the person perceives her objective power to perform the behavior accurately. The attitude towards the behavior is conceptualized by Ajzen (1991; cf. also Fishbein & Ajzen, 2010) as an expectancy-value model. According to this model, the expectancy that a behavior results in particular consequences and the evaluation, i.e., the valence of these consequences, are assumed to underlie the overall evaluation of the behavior.

Studies using the NAM explain environmental behavior as being influenced by (1) a personal ecological norm, denoting a strong intrinsic feeling of obligation to engage in the specific behavior. Prerequisites of the formation and activation of this personal norm are (2) the awareness of an environmental problem, (3) the awareness of effective action (we will speak of response efficacy in the following according to Lam and Chen (2006)) that can reduce the problem and (4) the recognition of the own ability to engage in these actions which might correspond very well to PBC of the TPB. Besides, personal norm, the consideration of (5) social implications, i.e. a perceived social norm, as well as (6) non-moral implications of action influences the behavior. These influences are also included within the TPB by the concepts of subjective norm and the attitude concept. A further influential variable contained in the NAM approach is (7) to assume responsibility for one's own actions and their consequences.

Figure 1 shows how the model of Bamberg and Möser (2007) has been adapted to explain the purchase of a fuel-efficient car. Corresponding to the TPB, attitude towards the purchase of fuel-efficient vehicles and the respective perceived

behavioral control are conceptualized as predictors of buying a fuel-efficient vehicle. Personal norm takes the role of TPB's third predictor social norm which receives a more indirect role of influence via affecting personal norm, attitude, and PBC. In line with the NAM, the awareness of ecological problems related to vehicle use and the response efficacy of one's own vehicle purchase are assumed as preconditions of the personal norm to buy a fuel-efficient vehicle. However, in contrast to the NAM, our suggested model does not include the internal attribution (or denial) of responsibility for consequences of one´s action or inaction. We did not explicitly include attribution of responsibility, as it should be closely related to response efficacy, i.e. the awareness that the own behavior has an effect with regard to the problem.

Various studies have shown the relevance of these factors for environmental transport behavior, in particular car purchase. Research indicates that many people have become *aware of the problems* of climate change and energy supply (Kuckartz, Rädiker, & Rheingans-Heintze, 2006; Anable, Lane, & Kelay, 2006) and relate them to some extent to car use (Lane & Potter, 2007; Nordlund & Garvill, 2003). However, there is evidence that detailed understanding of climate change and of the relationship between fuel use of vehicles and their CO_2 emissions is very low among consumers (Anable et al., 2006; DeCicco, 2006). People seem to have only vague or mistaken ideas about the most appropriate solutions to mitigate climate change (Patchen, 2006).

A study of Klocke (2002) indicates the influence of *attitude* on the purchase of such vehicles. With regard to *underlying specific belief*s (Ajzen, 2007) about the consequences of buying such vehicles, a survey by Turrentine and Kurani (2007) suggests that most consumers associate fuel economy with the smallest and cheapest

vehicles and do not perceive any difference between fuel economy and fuel efficiency. Those respondents for whom the two terms mean different things associate fuel efficiency – in contrast to fuel economy – with higher quality vehicles and new technology which, in turn, might be associated to a higher purchase price. Apparently, consumers assume fuel consumption to vary only marginally within one vehicle size class and conventional technology range (cf. Boardman, Banks, & Kirby, 2000). Thus, the perception that the only way to have a fuel-efficient vehicle is a trade-off against size, performance, comfort, safety and price (cf. also Kurani & Turrentine, 2004) might stabilize the disregard of fuel consumption in the purchase process. These associations also indicate subjective barriers which reduce *perceived behavioral control (PBC)* when fuel-efficient vehicles which are appropriate for one's needs are perceived as not available or as too expensive.

Also, the relevance of *social norms* for the intention of buying a fuel-efficient vehicle has been suggested in Klocke's study (2002). An influence on the purchase itself was not observed. In the field of travel mode choice, social norms as well as personal norms in favor of environmental mode choice have qualified as predictors of behavior (e.g., Bamberg, Hunecke, & Blöbaum, 2007).

As a new component beside these TPB and NAM components, we added symbolic motives, i.e., motives to express one's self and one's social position. Research has shown that symbolic motives play an important role for car use (Steg, 2005) as well as for car choice (Choo & Mokhtarian, 2004; Turrentine & Kurani, 2007). Today, status still seems to be considerably connected to vehicle size and performance. However, a study by Turrentine and Kurani (2007) indicates that fuel economy can be a symbolic feature as well if car drivers view resource conservation

as important value. At the time of this study (June 2006), traditional symbolic vehicle characteristics such as vehicle size and performance might still be of considerable symbolic value in contrast to fuel economy, although this may be changing.

A motive is a relatively stable trait which describes how important a person values a particular type of goals (Heckhausen, 1989). Thus, motives might influence the evaluation of moral and non-moral consequences of behavior with respect to that goal (cf. Schwartz & Howard, 1981), i.e., the personal norm as well as the attitude towards a behavior. Thus, we assume that symbolic motives connected to traditional symbolic vehicle characteristics exert an indirect negative influence on buying a fuel-efficient vehicle mediated by personal norm and attitude: Traditional symbolic motives may inhibit the activation of a personal norm to purchase a fuel-efficient vehicle. As well, they may influence the attitude via the perception and evaluation of possible consequences associated with buying a fuel-efficient vehicle.

With regard to financial aspects, on the one hand, an association of higher purchase prices with fuel-efficient vehicles may represent a relevant barrier for their purchase. On the other hand, saving money on gasoline could be a financial incentive. Economic assumptions that consumers rationally consider fuel consumption in their car use and purchase decisions with regard to the costs of gasoline over time have often been underlying studies to analyze, for example, the effect of rising gasoline prices (Kurani & Turrentine, 2004). In contrast, interviews conducted with automobile buyers reveal that consumers of all types miss the basic knowledge for such rational decision-making and value fuel economy not only because of cost savings (Turrentine & Kurani, 2007). Consumers of hybrid vehicles, for example, proved to be less interested in saving money than in environmental

issues addressed by their vehicle. This finding was also underlined by the knowledge differences regarding these two issues. Hence, we do not broaden our framework by the motivation to save costs over time and concentrate our study on the variables outlined above.

Based on the presented model, we want to study the determinants of the purchase of fuel-efficient vehicles. Our hypotheses are the following:

H1: PBC, attitude, and personal norm have a positive direct influence on the purchase of a fuel-efficient vehicle.

H2: Problem awareness, response efficacy, and social norm have a positive indirect influence on the purchase of a fuel-efficient vehicle which is mediated according to the paths in Figure 1.

H3: Traditional symbolic motives have a direct negative influence on personal norm and attitude and, thus, an indirect negative influence on the purchase of a fuel-efficient vehicle.

Finally, more exploratively, we want to analyze the consequences people associate with the purchase of fuel-efficient vehicles, i.e., the expected characteristics of such vehicles and people's evaluation of these characteristics.

3 Method

3.1 Participants

We only regard respondents whose households have bought a new vehicle since 2002. The corresponding data set for this study consists of 302 respondents and results from the following sampling procedure. A first questionnaire was sent out in June 2005 to 5890 households in the German- and French-speaking part of

Switzerland randomly chosen from the phone book. From 2333 respondents (response rate = 39.61%), 1545 (66.22%) were both willing to participate again and still reachable under their address. Of these, 1150 (response rate = 74.43%) returned a second questionnaire which was sent out in June 2006 and which contains the relevant modules of this study. Thus, we use only correlational data to test our hypotheses.

In our analyses, past vehicle purchase behavior up to four years ago is used as dependent variable and is explained by actual measures of hypothetically relevant psychological variables as indicators of their value at the time of the purchase. We focus on the purchase of new cars, as in the case of second-hand cars, the variables influencing the choice of a vehicle may be different again. Of the 1150 respondents, 359 (31.22%) had bought a new car since 2002. From this sample, the following records were excluded: (1) records with 50% of missing data or more for a multi-item predictor; (2) records for which technical data could not be assigned with satisfying quality for the vehicle(s) bought since 2002; (3) cases in which the second questionnaire was not filled out by the person who filled out the first questionnaire, and thus – according to our instructions –who was likely to buy the next car, or who had bought the last car (or was significantly involved in the decision process), or who used to drive the most.

The resulting sample of $N = 302$ respondents contains 79% men. For the time of the first survey in 2005, the mean age was 50.04 years (min. = 18, max. = 82, *S.D.* = 13.85), the median monthly household income was EUR[1] 5'351-6650 on a

[1] applied CHF/EUR exchange rate = 1.50.

categorical scale, the average household size was 2.65 persons (*S.D.* = 1.18; adults: *M* = 2.06, *S.D.* = 0.68; children: *M* = 0.60, *S.D.* = 0.95), and the average number of vehicles owned by a household was 1.62 (*S.D.* = 0.69).

Though for model testing, representativity of the sample is not a central requirement, this sample should ideally be representative for the population of Swiss new car buyers. Comparisons of the whole survey sample with the general population of Swiss car buyers reveal that single households are underrepresented and higher education households are overrepresented. Information on the income distribution for the whole population were not available; however, due to the empirical education-income-correlation, we also suppose that the sample contains more households with higher income than the underlying population of Swiss car buyers. With regard to the sub-sample of new car buyers, we assume that the deviations are transferable.

3.2 Vehicles

When households had bought more than one new vehicle since 2002, the youngest vehicle with data of satisfying quality was selected. Due to technological progress, average CO_2 emissions of European new car registrations have constantly decreased in the last 10 years. In order to compare CO_2 emissions of vehicles bought in different years – in analogy to the inflation correction of prices – we normalize CO_2 emissions relative to the market average of 2006, by assuming annual efficiency increases of 1.2% and 1.6% for gasoline and diesel engines, respectively.

3.3 Questionnaire

In this section, the relevant modules and items are shortly described.

CO_2 emissions of vehicles in possession. The respondents were asked to give detailed data on all cars currently owned by their household such as brand, model, fuel type, engine capacity, gear type, year of purchase, and model year (vintage). These data allow for a precise identification of any vehicle in the Swiss data base on vehicle type registrations and provide further technical characteristics including fuel consumption and CO_2 emissions of the vehicle. We use CO_2 emission as an indicator of the purchase of a fuel-efficient vehicle, as it allows a direct comparison of the energy demand of fossil fuel vehicles.

Psychological constructs. Each of the psychological constructs included in the theoretical model was measured by several items which were formulated specifically to the topic of car purchase and use, respectively. The items were based on Ajzen's (2007) general recommendations and on previous studies of environmental behavior (e.g., Hunecke, Blöbaum, Matthies, & Höger, 2001; Steg, 2005; Scholl & Sydow, 2002); in a few cases the exact wording was adopted while most of the items were modified to different degrees. Unless otherwise stated, respondents rated their agreement on a 5-point response scale ranging from 1 (= not at all the case) to 5 (= very much the case). Negatively formulated items were reversed in coding.

Before presenting the items related to the environmental consequences of car use in the questionnaire, 6 items were used to assess the respondents' symbolic motives connected to car purchase and use. Awareness of climatic and resource problems related to road transport was assessed by 6 items. As well, a set of 6 items served to measure response efficacy and 5 items to measure perceived behavioral control. Personal norm was assessed by 3 items. With regard to the operationalization of social norms, Ajzen (2007) differentiates between injunctive

and descriptive social norms. The injunctive norm describes whether most or, at least, important others approve or disapprove the behavior in question, whereas the descriptive norm describes whether they themselves perform this specific behavior. Of 3 items to measure social norm 2 were formulated in terms of an injunctive norm and 1 item in terms of a descriptive norm. The wordings of all these items are presented in Table 1. The items which finally constitute the confirmed indicators of the final measurement models are displayed in Table 4.

Finally, the general attitude towards fuel-efficient cars was assessed, as well as underlying beliefs about characteristics of fuel-efficient vehicles, i.e., expectancy and valence (cf. Ajzen, 2007). For the general attitude measure, subjects were asked to rate their general attitude towards fuel-efficient vehicles (1 = very negative; 5 = very positive). In order to explore which characteristics the respondents associate with fuel-efficient vehicles, respondents should assess a set of 12 associations (presented in Table 2) on how much they correspond to their image of such cars (expectancy rating). These items were intended to exploratorily reveal the salient consequences of a purchase of fuel-efficient vehicles as we did not explore them before the survey. Subsequently, respondents were asked to assess how negative vs. positive they would rate these criteria within car purchase (1 = very negative; 5 = very positive) to measure the valence of these conceivable characteristics of fuel-efficient vehicles.

Socio-demographic variables. Finally, questions for socio-demographic characteristics of the respondent and his or her household were included.

3.4 Analyses

For the multivariate data analysis, the structural equation approach was used (AMOS 6.0). First, the measurement models of the latent variables social norm,

PBC, personal norm, response efficacy, problem awareness, and symbolic motives were specified. In order to analyze the characteristics which the respondents associate with fuel-efficient vehicles and to include an exploratorily derived attitudinal measure into the SEM model, the expectancy and valence measures were examined by means of their descriptives and an exploratory factor analysis using the products of multiplying the respective expectancy and valence ratings. Based on the results and theoretical assumptions, we included three indicators for the latent attitude variable into the measurement model. The measurement models were tested via confirmatory factor analysis (CFA) applying maximum likelihood estimation. Based on the results, several items were excluded. For all of the constructs, unidimensionality could be confirmed. Finally, the combined measurement and structural model was tested (by maximum likelihood estimation).

4 Results

4.1 Descriptive results for the latent constructs

Latent constructs

Table 1 presents the wording, means, standard deviations, and reliability coefficients (Cronbach's alpha) of the items included in the questionnaire to assess the latent constructs (except for the indicator CO_2 emissions of the vehicles and the attitudinal predictor) as described above. The items measuring personal norm and response efficacy as well as PBC reach considerably high mean scores. The problem awareness items are still slightly above the neutral range of the response scale, as well as most of the items assessing symbolic motives. However, the items measuring the social norm to buy fuel-efficient vehicles expressed by the perceived expectations

as well as perceived behavior of important others is rather weak (except the social norm within the respondent's family). In general, the size of the standard deviations of all items is moderate.

Attitudinal ratings. With regard to characteristics associated with fuel-efficient vehicles, Table 2 depicts the means and standard deviations of the expectancy and valence ratings. The expectancy ratings show how much the respondents expect fuel-efficient vehicles to have the respective characteristic (1 = very low expectancy, 5 = very high expectancy). The valence ratings show how the respondents would evaluate the respective consequence when associated with a vehicle they consider buying (1 = very negative, 5 = very positive).

As the figures for the valence ratings show, the mean values of respondents' evaluation of cars with less power, slower acceleration, and smaller size range slightly below the scale mean of 3. A boring image, a higher purchase price, and less comfort received rather negative ratings. Decreased safety was the vehicle characteristic which was rated most negatively. In contrast, fuel saving through new technology, environmental soundness as well as new fuel types received the most positive ratings. For most of the items, the standard deviations indicate individual differences between the respondents which are a necessary prerequisite of predictive power of variables. Only the ratings regarding the characteristics fuel saving through new technology and environmental soundness indicate high agreement between the respondents.

However, which of these characteristics do the respondents mainly associate with fuel-efficient vehicles, i.e. which are the salient beliefs? The mean scores of the expectancy ratings indicate that the respondents strongly associate new technology,

environmental soundness, and new fuel types with fuel-efficient vehicles. Again, the ratings on new technology and environmental soundness show only low variance in contrast to the other items where the respondents differ more in their appraisal. Also less power, slower acceleration, and smaller size seem to be characteristics commonly associated with such vehicles with mean scores above or slightly above the scale mean of 3. A pioneer image is also perceived by the respondents, whereas decreased safety, less comfort and a boring image are least connected to fuel-efficient vehicles.

An exploratory factor analysis using the products of multiplying expectancy and valence (cf. Section 3.4) reveals four factors underlying these ratings (see Table 3) which can be described as expectation and valence of 1) environmental protection by technological progress, 2) less power and smaller size, 3) decreased safety and comfort, and 4) attractiveness and pioneer image. These factors are also found by factor analyses which are conducted separately on the expectancy and on the valence ratings.

In literature, it has been discussed how such expectancy and valence measures should be combined, mainly based on statistical argumentation (cf. Gagné & Godin, 2000). However, a generally accepted procedure is yet to be found. Because of scaling problems when multiplying two variables which are not measured on a ratio scale (Gagné & Godin, 2000), using only the valence ratings may be a reasonable solution. For the case of salient associations, differences in the respondents' evaluation should be predictive for the purchase of fuel-efficient vehicles. As we did not ask the respondents for their salient beliefs beforehand but instead let them rate what characteristics they associate mainly with fuel-efficient vehicles, we will focus

on the associations which seem to be more important in the respondents' mind. As salient associations we regard the items underlying the first two factors as these items get average expectancy ratings in the upper range of the scale. However, the items of the first factor concerning environmental protection by technological progress show little variation between the respondents with regard to their evaluation and tend to be evaluated positively by most respondents. Hence, we concentrate on the evaluations of the items loading on the second factor. Thus, as indicators for the latent attitude variable in the SEM analyses, the valence ratings of these three items (cars with a less powerful engine, cars which accelerate less than other cars, and smaller cars) were included into the measurement model.

CO_2 emissions of recently bought new vehicles. After correcting CO_2 emissions of the vehicles according to their respective purchase year such that they are comparable for market conditions of 2006 (cf. Section 3.2), the average CO_2 emissions of the respondents' vehicles have a mean of 185.77 g per km (min. = 104.00, max. = 345.85, *S.D.* = 41.29). A t-test with regard to deviations from the average of new car registrations in Switzerland in 2006 (187 g CO_2/km) reveals no significant differences.

4.2 Test of the measurement models

Psychological variables.

The confirmatory factor analysis which was conducted to test the measurement models of the predictor variables confirmed the seven factor structure after the following modifications. The following 3 items had to be removed because of cross loadings: (1) Social norm item 3 (cross-loading on PBC, personal norm and on social norm); (2) response efficacy item 6 (cross-loading on social norm and response

efficacy); (3) symbolic motives item 2 (cross-loading on valence of less power and size and symbolic motives). The two items response efficacy 1 and 2 were deleted because they exhibit high residual covariances. Only 2 of 5 items to assess PBC possess factor loadings above 0.4 which was considered as satisfying. Thus, the PBC items 1, 2 and 4 were removed. Finally, the average of the symbolic motives item 4 and 6 was used as their error term correlate. The measurement models of the constructs personal norm, problem awareness and valence of less power and size could be confirmed without modification.

The statistical fit of the revised measurement models presented in Table 4 is acceptable ($\chi^2 = 327.68$, df = 217, $p < .001$; $GFI = .91$, $AGFI = .88$, $CFI = .94$, $RMSEA = .04$).

The correlations between the dependent variable and the latent factors of the measurement models are presented in Table 5. The variables which are assumed as direct predictors of the purchase of a fuel-economical vehicle, valence of less power and smaller size, personal norm, and PBC, correlate highest with the dependent variable. Overall, the correlations between personal norm and the other model variables are the highest. PBC, in contrast, show the fewest significant correlations.

4.3 Structural equation modeling analyses

According to the model fit indices depicted in Figure 2, the suggested structural model produced an acceptable fit to the data. Valence of less power and size (attitudinal aspect), and PBC could be confirmed as significant direct predictors of the indicator of the dependent variable, fuel-economy of the vehicles in question,

indicated by their CO_2 emissions. However, the influence of personal norm on fuel-economy was only close to significance.

As factors directly influencing these predictors the variables response efficacy and symbolic motives could be empirically supported. A significant influence of social norm was observed only for personal norm. The influence of social norm on PBC only tended to reach significance. Problem awareness influences the direct predictors only indirectly via response efficacy and social norm as mediators. As this is the first application of the model to this case, the reason for some paths not being significant could be related to the sample and to effects being suppressed due to small overlaps with other variables. This is underlined by the observed bivariate correlations, e.g., between the dependent variable purchase of a fuel-economical vehicle and personal norm. Therefore, we kept the paths that do not reach significance in the model. Together, the predictors explain 29% variance of the fuel-economy of the vehicles in question.

5 Discussion and conclusion

The aim of this paper was to test an integrated model of psychological determinants influencing the purchase of fuel-economical vehicles. Based on a meta-analytic SEM of psychological determinants of environmental behaviors by Bamberg and Möser (2007), this model integrates the TPB and the NAM predictors. Specifically for car purchase, symbolic motives were hypothesized as additional indirect predictor. At the time of the study, we assume these symbolic motives to be mainly connected to traditional symbolic vehicle characteristics such as vehicle size and performance. Such traditional symbolic motives should exert a negative

influence on the purchase of a fuel-efficient vehicle. Finally, we wanted to analyze the image people associate with (more) fuel-economical vehicles.

The results of the SEM analyses indicated an acceptable model fit of the original postulated model. The attitudinal aspect valence of less power and smaller size and PBC could be confirmed as direct predictors of the purchase of a fuel-efficient vehicle and personal norm tended to influence the dependent variable, but did not reach significance. Together, they can explain 29% variance of the dependent variable. In Bamberg and Möser's (2007) meta-analysis, on average 27% variance of self-reported environmental behavior was explained. Thus, the result of our model seems to be in an acceptable range.

As hypothesized, the construct of symbolic motives has significant negative influence on two of the direct predictors – personal norm and valence of less power and size – and thus, inhibits indirectly the purchase of a fuel-efficient vehicle. Besides this negative impact of symbolic motives, the three direct predictors valence of less power and size, personal norm, and PBC are positively influenced by response efficacy and partly by social norm, as well as indirectly by problem awareness mediated by these two variables.

Our results concerning the characteristics associated with fuel-efficient vehicles reflect the salience of the positively valued features of new technology and alternative fuels. As well, smaller size and less power are common associations; however, the respondents differ in their attitude towards these characteristics.

Our study contributes to the development and testing of theoretical frameworks for people's environmental decisions which integrate different motives and specify their interaction and relative importance (cf. Bamberg et al., 2007). It indicates which

psychological determinants could enrich models to explain and forecast car choice behavior with the aim of developing measures to change behavior.

It is important to keep in mind that the survey was conducted within an early stage of public attention towards topics related to the fuel consumption of vehicles. Till summer of 2006, the oil price had been still below 80 US-$/barrel, whereas in 2007, it had dramatically been rising to almost 100 US-$/barrel. As well, public's attention to climate change has increased considerably since the release of part one of a series of reports of the IPCC's fourth assessment (2007b). Thus, the variables in the focus of this study may be changing. For instance, fuel economy might gain more symbolic value and social norms which support the purchase of fuel-economical vehicles more strongly might develop.

With regard to critical aspects, we have to point out that the causal interpretations of our study should be handled with care as we used correlational data. Furthermore, the vehicles in question have been bought up to four years before the psychological constructs were assessed. Thus, it is possible that the psychological factors have changed since then. This could imply that the associations would be higher if the predictors had been measured at the time of the purchase.

Finally, we want to emphasize the practical implications of this study: The items measuring perceived behavioral control indicate that information and prompts, such as fuel efficiency labels, could be effective to help consumers to better identify fuel-efficient vehicles and to make them aware that fuel-efficient versions of almost every vehicle model exist. The results on the characteristics associated with fuel-efficient vehicles (smaller size or less power and acceleration) suggest to better inform people that such vehicles do not necessarily need to be smaller or accelerate

less in most everyday situations. In general, fuel efficiency should be promoted as a popular feature. The public sector could take a leading role and make fuel efficiency a prominent selection criterion for its car fleets. As well, financial incentives could emphasize the social desirability of a change of purchase behavior. As prerequisite, consumers should be better informed about the problems related to fuel consumption and about the broad range of own action within car purchase to reduce these problems, i.e. their fuel consumption, effectively. In general, various measures starting at different relevant factors and supporting each other should be combined.

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Captions to Tables

Table 1. Wording, means, and standard deviations (*S.D.*) of the items included in the questionnaire to operationalize the latent variables (except attitude and the behavior) and corresponding reliability coefficients (Cronbach's alpha) ($N = 302$).

Table 2. Description of expectancy and valence for conceivable characteristics of fuel-efficient vehicles ($N \geq 298$). Item wording for the expectancy items: "When thinking of fuel-efficient vehicles, I think of …"; response scale: 1 = not at all the case (very low expectancy); 5 = very much the case (very high expectancy). Item wording for the valence items: "Within car purchase, how do you evaluate …"; response scale: 1 = very negative; 5 = very positive.

Table 3. Dimensions and factor loadings resulting from an exploratory PCA on the expectancy and valence measures concerning conceivable characteristics of fuel-efficient vehicles ($N \geq 298$). The PCA used the products of multiplying the respective expectancy and valence ratings. The numbers represent the loadings above .4 after factor rotation according to the Varimax criterion and selection of four factors considering the Kaiser-Guttman criterion, Scree plot, and theoretical reasonability.

Note: ProgEnv= expectation and valence of environmental protection by technological progress, PowSize = expectation and valence of less power and smaller size, SafeComf = expectation and valence of decreased safety and comfort, AttrImage = expectation and valence of attractiveness and pioneer image.

Table 4. Measurement models for the seven latent model variables (λ = standardized factor-loadings).

Table 5. Correlations between the model variables (*p ≤ .05; ** p ≤ .01; *** p ≤ .001; [a]indicated by CO_2 emissions of the owned vehicle)

Captions to Figures

Figure 1. Theoretical integrated model to explain CO_2 emissions of new vehicles, adapted from Bamberg and Möser (2007), enriched with symbolic motives. “+” indicates positive influence, “-“ indicates negative influence.

Figure 2. Significant results of the estimated SEM: significant standardized structural coefficients (*$p \leq .05$; ** $p \leq .01$; *** $p \leq .001$), explained variances, and model fit indices.